HUKX

Sensor
Technology

Brochure

Self-calibrating heat flux sensors

FHF05SC series

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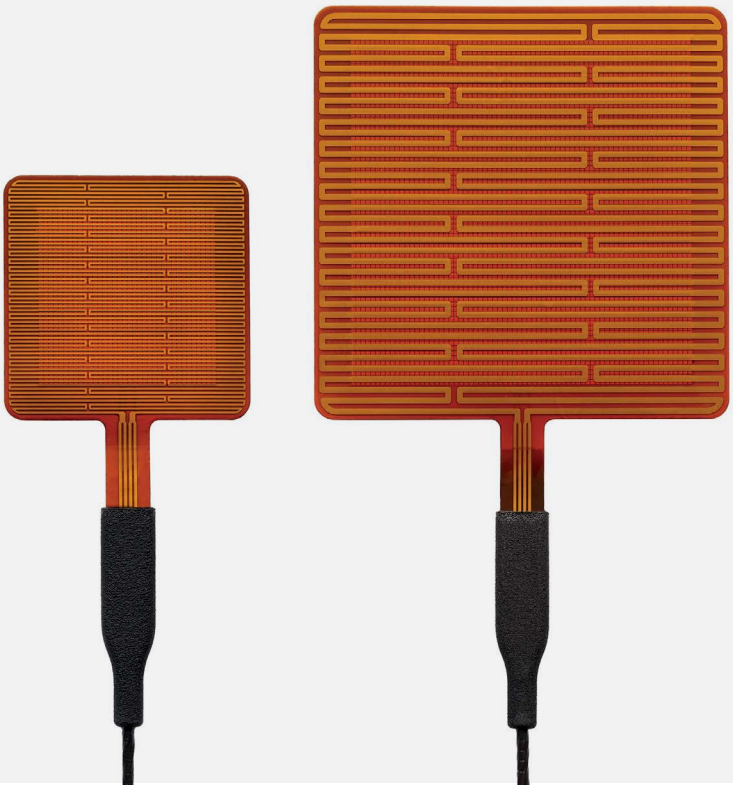
Self-calibrating heat flux sensors

Two self-calibrating foil heat flux sensors with thermal spreaders and heater

Introducing next-level sensors from the world market leader in heat flux measurement! FHF05SC sensors are a combination of our standard models FHF05 series heat flux sensors and an integrated heater. The heater allows you to perform self-tests, verifying sensor functionality and stability during use, without having to remove the sensor.

FHF05SC series is ideal for high-accuracy and long-term heat flux measurement, construction of calorimeters, (zero heat flux) core temperature measurement, and thermal conductivity test equipment. Available in two models: standard model size 50X50 mm and a larger, more sensitive size of 85X85 mm.

Figure 1 Model FHF05SC-50X50 and FHF05SC-85X85 self-calibrating heat flux sensor with heater: thin, flexible, and versatile.



self-calibrating

incorporated heater

IP67 rated

flexible design

Introduction

FHF05SC self-calibrating sensors consist of a heat flux sensor, combined with a heater. This combination is used when the highest level of quality assurance is required and for long-term heat flux measurements.

The thin, flexible, and versatile FHF05SC sensors measure heat flux (in W/m^2) either through the object in which they are incorporated or on which they are mounted. Each sensor contains a thermopile that measures the temperature difference across FHF05SC's flexible body, which directly translates to heat flux. A Type T thermocouple provides additional temperature measurement. Both the thermopile and the thermocouple are passive sensors and do not require external power.

Multiple small thermal spreaders form a conductive layer covering the sensor, reducing the measurement's dependence on thermal conductivity. With these incorporated spreaders, the sensitivity of FHF05SC sensors is independent of the thermal properties of their environment. Many competing sensors do not have thermal spreaders, so their sensitivity cannot be relied upon since it varies depending on the material on which they are mounted.

The unique feature of the FHF05SC sensors is an incorporated heater. This heater may be used, switched on for several minutes, for self-testing purposes. When activated, the heater does require power.

Looking for heat flux and temperature measurement without the heater? See our FHF05 series heat flux sensors for more information.

Figure 2 FHF05SC-50X50 being installed to measure heat flux on a curved surface.

Unique features and benefits

– heater for self-testing purposes
– flexible (bending radius ≥ 15 x 10^{-3} m)
– low thermal resistance
– wide temperature range
– fast response time
– integrated Type T thermocouple
– robust design, including cable connection block for strain relief
– IP67 protection rating (essential for outdoor and humid environments)
– integrated thermal spreaders for low thermal conductivity dependence

Using an FHF05SC sensor is easy. For heat flux measurements, it connects directly to commonly used data logging systems. The heat flux (in W/m^2) is calculated by dividing the sensor output, a small voltage, by the sensitivity—which is provided on the sensor's product certificate. When used under conditions that differ from the calibration reference conditions, the FHF05SC series' sensitivity to heat flux may be different than stated on its certificate. See the user manual for suggested solutions.

Also, make sure your data acquisition accepts Type T thermocouples to perform temperature measurements.

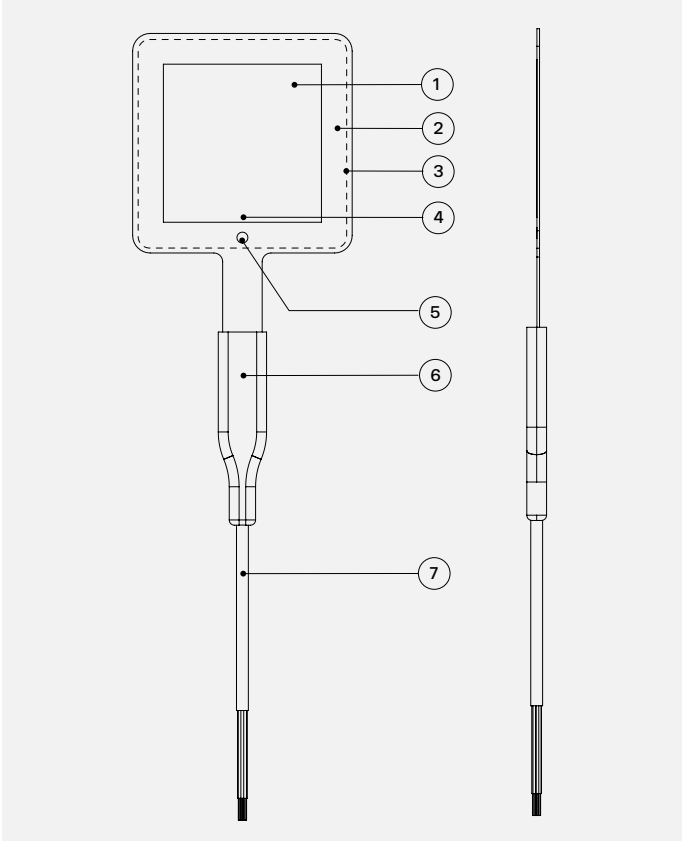


Figure 3 FHF05SC heat flux sensor:
1. sensing area with thermal spreaders
2. passive guard
3. contour of the heater area for self-test
4. Type T thermocouple
5. dot indicating front side
6. cable connection block for strain relief
7. cable, standard length C is 2 m

Figure 4 Working with FHF05SC-85X85 on a metal wall.

Self-testing

When measuring heat flux, you may wish to regularly check their sensor's performance. During use, the film heater can be temporarily activated for several minutes to perform a self-test, including self-calibration. The heat flux sensor's response during self-test verifies its performance. Cable connection, data acquisition, thermal connection of the sensor to its environment, and data processing are also implicitly tested. Heat flux sensors are often installed for long periods of time. Using self-testing, the user no longer needs to take sensors to the laboratory to verify their stable performance. The heater has a well-characterized and traceable surface area and electrical resistance.

Suggested use

– high-accuracy scientific measurement of heat flux, with a high level of data quality assurance
– study of convective heat transfer mechanisms
– calorimeter prototyping
– (zero heat flux) non-invasive core temperature measurement
– thermal conductivity test equipment

Measurement and control

Requirements for data acquisition and control:
– for heat flux: one millivolt measurement
– for heater voltage: one voltage measurement
– optional, for heater current: one current measurement or voltage measurement over a resistor
– for switching the heater current on and off: one relay with 12 VDC nominal output
– for temperature: Type T thermocouple

Robust and stable

FHF05SC sensors are equipped with a potted cable connection block that prevents moisture from entering and may also serve as strain relief—proving its robustness and stability in demanding environments.

Figure 5 Model FHF05SC-50X50 and FHF05SC-85X85 heat flux sensors' front side.

Application example

The FHF05SC heater can be used to check for stable performance of the sensor at regular intervals without the need to uninstall the sensor or interrupt operation. A typical stability check is based on analysis of the step response of the measured heat flux and sensor temperature to several minutes of heating.
Upon installing the sensor, a reference measurement should be made. A time trace of the heater voltage, the measured heat flux, and the measured sensor temperature should be stored as a reference measurement.

Stable operation of the sensor can then be confirmed at any time by repeating the test and comparing heat flux and temperature signals to the reference measurement.

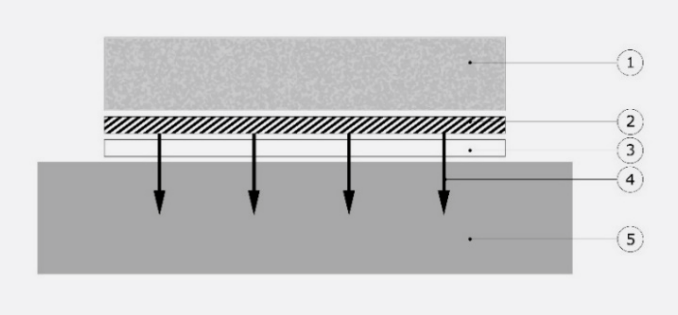


Figure 6 Calibration of FHF05SC series; a typical stack used for calibration consists of a block of metal (mass > 1 kg), for example aluminium (5), the heat flux sensor (3), with heater (2), and an insulation foam (1). Under these conditions, heat losses through the insulation are negligible. Heat flux (4) flows from hot to cold.

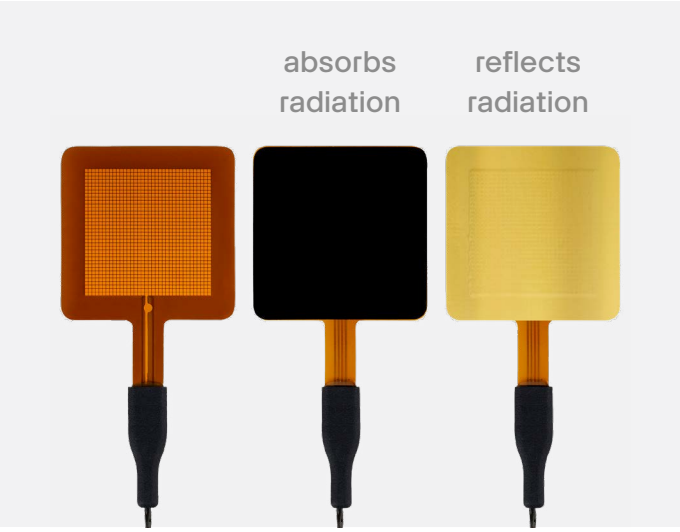


Figure 7 FHF05SC heat flux sensor with BLK-50X50 and GLD-50X50 stickers.

GLD and BLK sticker series

Want to study energy transport or heat flux in detail? Hukx helps take your measurement to the next level: order FHF05SC with radiation-absorbing black and radiation-reflecting gold stickers. You can then use one sensor to measure convective + radiative flux and the other to measure convective flux only. Subtract the two measurements to obtain radiative flux.

You can apply the BLK – GLD stickers to the sensor, with stickers available for every sensor dimension. Optionally, they can be ordered pre-applied on the FHF sensors. See the BLK – GLD sticker series user manual and installation video for instructions.

Options

- with 5 or 10 m cable lengths
- separate cable in 2, 5, or 10 m lengths
- LI19 hand-held read-out unit/data logger
  NOTE: LI19 measures heat flux only, not temperature, and does not support the self-test functionality.
- BLK black sticker (to measure radiative as well as convective heat flux)
- GLD gold sticker
  (to measure convective heat flux only)
- BLK – GLD sticker series can also be ordered pre-applied at the factory

See also

- FHF05 series, our standard sensor models for general-purpose heat flux measurement
- model HFP01 (used on walls and in soils as a lower cost alternative to FHF05- 85X85)
- model FHF06: for applications up to 250 °C
  BLK – GLD sticker series for separating radiative and convective heat fluxes
- Hukx offers a complete product range of heat flux sensors with the highest quality for any budget

FHF05SC series specifications

measurand	heat flux
measurand	temperature
temperature sensor	Type T thermocouple, IEC 60584-1 Class 2*
thermal spreaders	included
online functionality testing	self-test including self-calibration
rated bending radius	≥ 15 x 10^{-3} m
rated load cable	≤ 1.6 kg
outer dimensions foil with guard	(50X50) x 10^{-3} m (85X85) x 10^{-3} m
sensor thermal resitance	24 x 10^{-4} K/(W/m^2)
sensor thickness	0.7 x 10^{-3} m
uncertainty of calibration	± 5 % (k = 2)
measurement range	(-10 to +10) x 10^{3} W/m^2
sensitivity (nominal) per model 50X50: 85X85:	 13 x 10^{-6} V/(W/m^2) 50 x 10^{-6} V/(W/m^2)
rated temperature range continuous use: short intervals:	 -40 to +120 °C** -160 to +150 °C**

IP protection class	IP67***
standard wire length	2 m
heater resistance per model 50X50: 85X85:	 120 Ω (nominal) 40 Ω (nominal)
heater power supply	12 VDC
options	5 or 10 m cable length without cable**** BLK black sticker GLD gold sticker

* The temperature measurement uncertainty is ± 1 or 0.0075 × T °C. For details, see the user manual.

** When measuring at temperatures of -160 °C, contact Hukx.

*** See appendix on long-term use under condensing, wet and underwater conditions.

**** Sensor foil only (without cable and cable connection block) may be used in vacuum.

About Hukx

Hukx is the leading innovator in solar radiation and heat flux sensor technology. We are proud to set the standard in high-accuracy measurement, and to be working at the heart of the energy transition.

Customers worldwide rely on our bestselling pyranometers and heat flux sensors. From sensor design and selection to supply and recalibration, we support you across the entire lifecycle.

Hukx is headquartered in the Netherlands, with locally owned representative sales offices in the USA, Brazil, India, China, Southeast Asia, and Japan.

Let us help you select the best sensor for your application.
Get in touch with our experts today via: info@hukx.com

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